

What is claimed is:

1. A magnetic memory device having a non-volatile magnetic section including:

a first interconnection;

5 a second interconnection crossing said first interconnection in a grade-separated manner; and

a tunnel magneto resistance element electrically insulated from said first interconnection and electrically connected to said second interconnection, the tunnel magneto resistance element including a tunnel barrier layer interposed between ferromagnetic materials within a region in which said first and said second interconnections cross; wherein said non-volatile magnetic section stores information by utilizing a change in resistance depending on whether spin directions of said ferromagnetic materials are parallel or antiparallel; the non-volatile magnetic section comprising:

a through hole for connecting said tunnel magneto resistance element with an interconnection layer lower than said first interconnection, said through hole passing through said first interconnection while being insulated from said first interconnection; and

a contact formed in said through hole for interconnecting said interconnection layer lower than said first interconnection and a side of said tunnel magneto resistance element which is opposite to a side which said second interconnection is connected to.

2. The magnetic memory device according to claim 1, wherein said first interconnection comprises a plurality of interconnections, and said contact connects the side of said tunnel magneto resistance element which is opposite to the

side to which said second interconnection is connected and another interconnection layer through said through hole passing through said first interconnection while being insulated from said first interconnection.

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3. The magnetic memory device according to claim 1, wherein

said first interconnection includes a flux concentrator comprising a high permeability film provided at least on both
10 sides of said first interconnection and on an surface which is opposite to the side that faces said tunnel magneto resistance element;

at least one of said high permeability films on the side face of said first interconnection projects from said first
15 interconnection toward said tunnel magneto resistance element; and

said through hole extends through said first interconnection and said flux concentrator while being insulated from both said first interconnection and said flux
20 concentrator.

4. The magnetic memory device according to claim 1, further comprising:

a flux concentrator including a high permeability film
25 provided between said first interconnection and said tunnel magneto resistance element, and on the side face of said tunnel magneto resistance element via an insulator film; and

said through hole extends through said first interconnection and said flux concentrator while being
30 insulated from both said first interconnection and said flux concentrator.

5. The magnetic memory device according to claim 1, further comprising:

5 a first flux concentrator including a high permeability film provided at least on both sides of said first interconnection, and on an surface which is opposite to the side that faces said tunnel magneto resistance element;

10 a second flux concentrator including a high permeability film provided between said first interconnection and said tunnel magneto resistance element, and on the side face of said tunnel magneto resistance element via an insulator film; and

15 said through hole extends through said first interconnection and said first and second flux concentrators while being insulated from said first interconnection and said first and second flux concentrators.

6. A method for manufacturing a magnetic memory device, comprising the steps of:

20 fabricating a first interconnection on a substrate having an insulated surface;

forming an insulator film for covering said first interconnection;

25 opening a through hole extending from said insulator film to an interconnection layer formed on said substrate, through said first interconnection;

forming a side wall barrier film on a side wall of said through hole;

forming a contact inside said through hole;

30 forming a tunnel magneto resistance element electrically insulated from said first interconnection and

connected to said contact, including a tunnel barrier layer interposed between ferromagnetic materials; and

5 fabricating a second interconnection electrically connected to said tunnel magneto resistance element and crossing said first interconnection in a grade-separated manner with said tunnel magneto resistance element interposed therebetween.

10 7. The method for manufacturing a magnetic memory device according to claim 6, wherein said first interconnection is formed with a plurality of interconnections, and said through hole is provided between said plurality of first interconnections.

15 8. A method for manufacturing a magnetic memory device comprising the steps of:

forming a high permeability film, a first interconnection layer and an insulator film in ascending order on a substrate having an insulated surface;

20 opening a through hole extending from said insulator film to an interconnection layer formed on said substrate through said first interconnection layer and said high permeability film;

25 forming a side wall barrier film on a side wall of said through hole;

forming a contact in said through hole;

forming a dummy film on said insulator film;

30 etching a multi-layered film ranging from said dummy film to said high permeability film into a shape of a first interconnection;

forming a flux concentrator with said high permeability

film and a high permeability side wall comprising a high permeability material, wherein said high permeability side wall is formed on a side wall of said multi-layered film formed into the shape of said first interconnection;

5 removing said dummy film;

 forming a tunnel magneto resistance element configured with a tunnel barrier layer interposed between ferromagnetic materials and is connected to said contact; and

 forming a second interconnection that is electrically
10 connected to said tunnel magneto resistance element and crossing said first interconnection in a grade-separated manner with said tunnel magneto resistance element interposed therebetween.

15 9. The method for manufacturing a magnetic memory device according to claim 8, wherein said first interconnection is formed with a plurality of interconnections, and said through hole is provided between said plurality of first interconnections.

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10. A method for manufacturing a magnetic memory device comprising the steps of:

 forming a high permeability film, a first interconnection layer and a first insulator film in ascending order on a
25 substrate having an insulated surface;

 opening a through hole extending from said first insulator film to an interconnection layer on said substrate through said first interconnection layer and said high permeability film;

30 forming a side wall barrier film on a side wall of said through hole;

forming a contact in said through hole;

etching a multi-layered film ranging from said first insulator film to said high permeability film into a shape of a first interconnection;

5 forming a flux concentrator with said high permeability film and a first high permeability side wall comprising a high permeability material by forming said high permeability side wall on a side wall of a multi-layered structure formed into the shape of said first interconnection;

10 forming a second insulator film that covers said first insulator film, said contact and said flux concentrator, and then planarizing said second insulator film, while making an end of said flux concentrator exposed;

15 forming, on said first insulator film, a tunnel magneto resistance element configured with a tunnel barrier layer interposed between ferromagnetic materials and connected to said contact;

forming a side wall barrier film on a side wall of said tunnel magneto resistance element;

20 forming, on a side wall of said tunnel magneto resistance element through said side wall barrier film, a second high permeability side wall connected to said end of said flux concentrator; and

25 forming a second interconnection electrically connected to said tunnel magneto resistance element and crossing said first interconnection in a grade-separated manner with said tunnel magneto resistance element interposed therebetween.

11. The method for manufacturing a magnetic memory
30 device according to claim 10, wherein said first interconnection is formed with a plurality of interconnections, and said through

hole is provided between said plurality of first interconnections.

12. A method for manufacturing a magnetic memory device
5 comprising the steps of:

forming a first interconnection on a substrate having an insulated surface;

forming a first insulator film that covers said first interconnection;

10 forming a high permeability film and a second insulator film in ascending order on said first insulator film;

opening a through hole extending from said second insulator film to an interconnection layer on said substrate through said high permeability film, said first insulator film
15 and said first interconnection;

forming a side wall barrier film on a side wall of said through hole;

forming a contact in said through hole;

forming, on said second insulator film, a tunnel magneto
20 resistance element that is configured with a tunnel barrier layer interposed between ferromagnetic materials and connected to said contact;

forming a side wall insulator film on a side wall of said tunnel magneto resistance element, while making said high
25 permeability film exposed;

forming a flux concentrator with said high permeability film and a high permeability side wall, said high permeability side wall formed on a side wall of said tunnel magneto resistance element connected to said high permeability film via
30 said side-wall barrier film; and

forming a second interconnection electrically connected

to said tunnel magneto resistance element and crossing said first interconnection in a grade-separated manner with said tunnel magneto resistance element interposed therebetween.

- 5 13. The method for manufacturing a magnetic memory device according to claim 12, wherein said first interconnection is formed with a plurality of interconnections, and said through hole is provided between said plurality of first interconnections.

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14. A method for manufacturing a magnetic memory device, comprising the steps of:

- forming a high permeability film, a first interconnection layer and a first insulator film in ascending order on a substrate having an insulated surface;

- 15 etching a multi-layered film ranging from said first insulator film to said first high permeability film into a shape of a first interconnection;

- forming a first flux concentrator with said high permeability film and a first high permeability side wall including a high permeability material, said high permeability side wall formed on a side wall including said multi-layered structure formed into the shape of said first interconnection.

- 20 forming a second insulator film covering said first flux concentrator and said first insulator film;

- forming a second high permeability film and a third insulator film in ascending order on said second insulator film;

- opening a through hole extending from said third insulator film to an interconnection layer on said substrate through said second high permeability film, said second insulator film, said first insulator film, said first

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interconnection and said first flux concentrator;

forming a side wall insulator film on a side wall of said through hole;

forming a contact in said through hole;

5 forming, on said third insulator film, a tunnel magneto resistance element having a tunnel barrier layer interposed between ferromagnetic materials and being connected to said contact;

forming a side wall barrier film on a side wall of said
10 tunnel magneto resistance element while making said second high permeability film exposed;

forming a second flux concentrator with said second high permeability film and a second high permeability side wall by forming, on a side wall of said tunnel magneto resistance
15 element through said side wall barrier film, said high permeability side wall s connected to said second high permeability film; and

forming a second interconnection electrically connected to said tunnel magneto resistance element and crossing said
20 first interconnection in a grade-separated manner with said tunnel magneto resistance element interposed therebetween.

15. The method for manufacturing the magnetic memory device according to claim 14, wherein said first interconnection
25 is formed with a plurality of interconnections, and said through hole is provided between said plurality of first interconnections.